6 The Paving Operation

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Ponding
Curing Compound

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Removal of Forms

CHAPTER SIX:
THE PAVING OPERATION

Once the subgrade or base course has been checked for true line and grade, the paving operation may begin.

The paving operation is a straight forward and systematic series of steps. This chapter will cover each step in the paving operation and explain why each is necessary for a quality concrete product. The following topics will be discussed:

1) Checking the condition of the grade
2) Checking placement of reinforcing steel and joint assemblies
3) The duties of the plant technician
4) Mixing and placing concrete
5) Finishing and curing concrete
6) Observing weather restrictions

CONDITION OF GRADE

The prepared subgrade or base course is required to be maintained in a smooth and compacted condition up to the time paving begins.

A dry grade will absorb moisture from the concrete. Therefore, the grade is required to be uniformly moist when the concrete is placed. Spraying water on the grade ahead of the paving operation may be necessary (Figure 6-1). Care should be taken to avoid creating mud or pools of water.

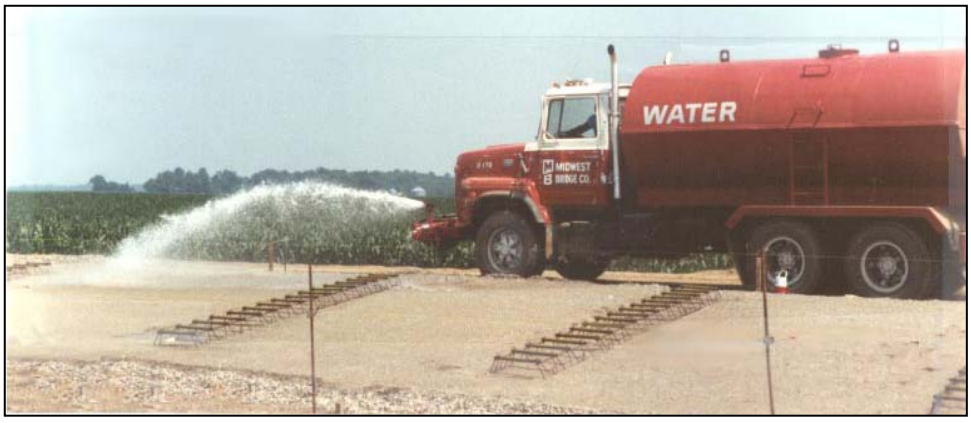


Figure 6-1. Subgrade Preparation

DOWEL BARS AND ASSEMBLIES

Dowel bars are smooth, epoxy coated, steel bars which are placed at all transverse joints to provide load transfer across the joints. Dowel bars allow the pavement to slide freely at the joint during expansion and contraction of the pavement. When the dowel bars are used for expansion joints, the free end of each bar has an expansion tube attached to the bar.

Generally, dowel bars are mounted in a welded wire assembly referred to as a basket (Figure 6-2). This basket holds all of the dowel bars evenly and securely in place so they do not shift during the paving operation. If paving over a granular grade, sand plates under the baskets may be necessary to keep the baskets from being pushed into the grade.

The entire dowel bar assembly, or basket, is secured to the grade with basket pins. There must be at least 8 basket pins in a 10, 11, or 12 foot assembly.

Figure 6-2. Dowel Bar Placement

Dowel bars are required to be inspected for vertical and horizontal alignment before paving. The entire assembly is required to be physically checked for vertical and horizontal alignment at least every 2000 feet. If there is a question about the stability of the basket during the paving operation, a dowel bar check may be necessary after the concrete has been placed. If this is required, the concrete is removed from the ends of each dowel bar on the assembly and each bar is checked. This procedure is done quickly because any correction is required to be made while the concrete is still plastic.

Figure 6-3. Dowel Bar Checker

Vertical alignment may be checked with a dowel bar checker (Figure 6-3). This device is first placed on the form or grade next to the basket being checked, and the bubble is leveled to conform to the grade. Each dowel is then checked. If the bubble is not in the center, one leg of the checker is lifted until the bubble is in the center. If this correction is more than 1/4 inch, the dowel bars are required to be corrected.

Horizontal alignment is checked by measuring the distance from each end of the dowel to the form or string line and comparing the two measurements. If the measurements differ by more than 3/8 inch, the horizontal alignment is required to be corrected.

The deviation of any bar after the pavement has been finished is required to be no greater than an angle the tangent of which is 1/48. This means that the bar cannot deviate by more than ¼ in. per foot. This is generally a simple requirement to meet and, if baskets are stored and handled properly, there should be very few problems.

All dowel bar checks are documented and these records are included in the contract file. Before paving begins, all connection wires on the baskets are required to be cut near the center of the tie.. Dowel bars are coated with an approved material to break the bond with the concrete.

PLANT TECHNICIAN

The technician at the concrete plant is responsible for assuring that INDOT receives the quality of materials the Contractor has agreed to supply and for assuring that those materials are delivered in the proper quantities.

The plant technician is required to observe all weighing, batching, and mixing operations at the plant site. All materials are sampled, tested, and approved. The scales used for batching the cement and aggregates are checked for accuracy twice a day.

The plant technician should maintain a cooperative relationship with the Contractor and plant personnel. The technician should know the Specification requirements and if in doubt ask for assistance. For a more detailed list of the plant technician's duties, the daily check list (Form IC 739) should be reviewed. Examples of Form IC 739 are on pages 6-19 and 6-20.

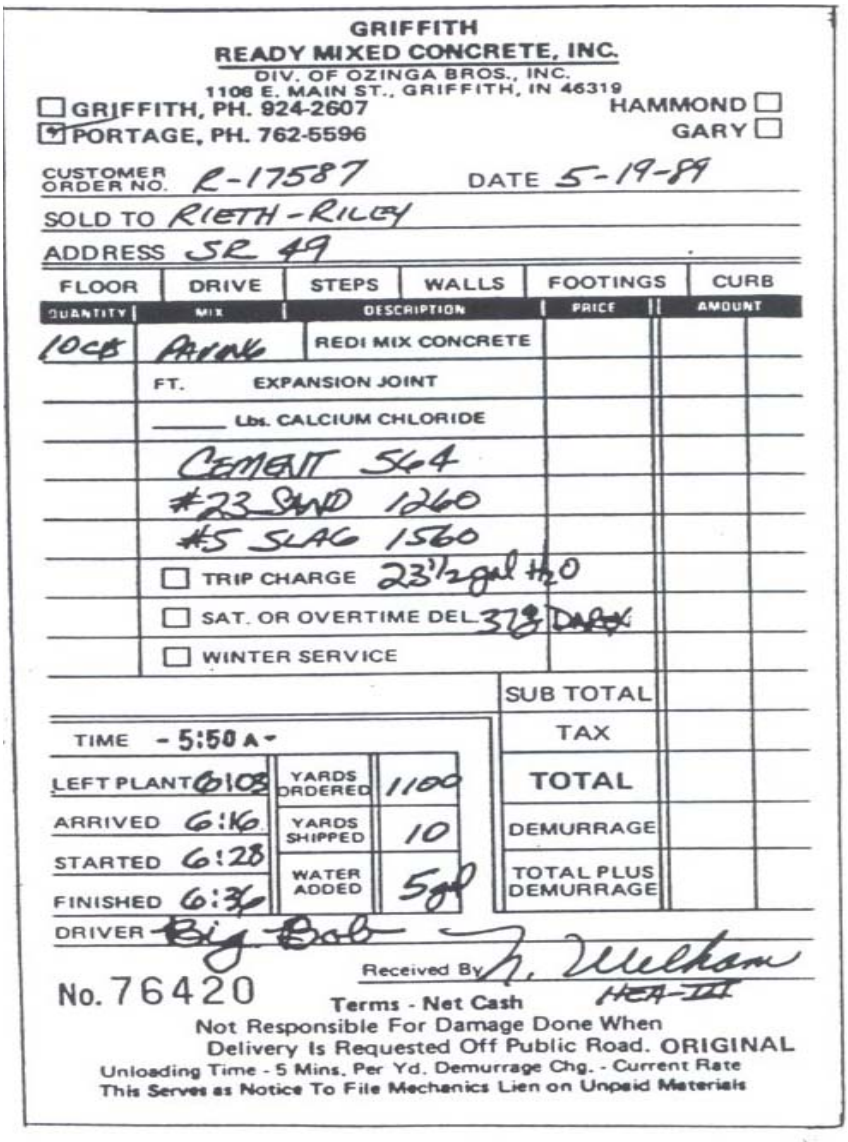
MIXING CONCRETE

Concrete may be mixed in any of the following ways:

1) On site mixers (these mixers are rarely used and will not be discussed)
2) Central mix plants
3) Ready-mix plants using transit mixers

If transit mixer trucks are used, the concrete is required to be mixed for 70 to 100 revolutions. When central mix concrete is used, the mixing time shall be no less than 60 seconds.

Water may need to be added to transit mix concrete at the paving site. This may only be done within 45 minutes from the time the water was added at the plant. If the proper slump cannot be achieved by this time, the PE/PS should be consulted for assistance. If adding water to the concrete trucks becomes routine, a correction needs to be made in the amount of water being added at the plant. The amount of water added is required to be noted on the concrete tickets (Figure 6-4) for the permanent record.



GRIFFITH
READY MIXED CONCRETE, INC.
DIV. OF OZINGA BROS., INC.
1106 E. MAIN ST., GRIFFITH, IN 46319

☐ GRIFFITH, PH. 924-2607 HAMMOND ☐
☑ PORTAGE, PH. 762-5596 GARY ☐

CUSTOMER ORDER NO. R-17587 DATE 5-19-89
SOLD TO RIETH-RILEY
ADDRESS SR 49

FLOOR	DRIVE	STEPS	WALLS	FOOTINGS	CURB

QUANTITY	MIX	DESCRIPTION	PRICE	AMOUNT
10CB	AA1WG	REDI MIX CONCRETE		
	FT.	EXPANSION JOINT		
	____ Lbs.	CALCIUM CHLORIDE		
		CEMENT 564		
		#23 SAND 1260		
		#5 SLAG 1560		
	☐	TRIP CHARGE 23½gal H_2O		
	☐	SAT. OR OVERTIME DEL. 37½ DARK		
	☐	WINTER SERVICE		
			SUB TOTAL	
			TAX	
			TOTAL	
			DEMURRAGE	
			TOTAL PLUS DEMURRAGE	

TIME - 5:50 A -

LEFT PLANT 6:05	YARDS ORDERED	1100
ARRIVED 6:16	YARDS SHIPPED	10
STARTED 6:28	WATER ADDED	5gal
FINISHED 6:36		

DRIVER Big Bob
Received By R. Welham HEA-III
No. 76420
Terms - Net Cash
Not Responsible For Damage Done When Delivery Is Requested Off Public Road. ORIGINAL
Unloading Time - 5 Mins. Per Yd. Demurrage Chg. - Current Rate
This Serves as Notice To File Mechanics Lien on Unpaid Materials

Figure 6-4. Concrete Ticket

Concrete is required to be placed in a timely manner. Once the water is added at the concrete plant, the concrete is required to be placed within 90 minutes if hauled in transit mixers or truck agitators, or within 30 minutes if hauled in non-agitator trucks. The actual time the water was added is stamped on the ticket.

Chemical admixtures, Type B, Type C, and Type E, are permitted only with prior written approval. All other chemical admixtures may be used without written approval. Different brands of cement are not allowed to be used alternately, nor mixed. A Contractor may elect to use class "C" concrete which requires the use of a water reducer or retarder admixture. The water required for a workable mix allows for a lower water-cement ratio and faster strength. A retarder is generally used in warm weather to slow the set of the concrete, therefore keeping the concrete workable longer.

WEATHER RESTRICTIONS

Sufficient lighting is required for the concrete paving operations. If paving continues after dark, lighting is used so that all operations are visible.

Unless authorized in writing, concrete paving may only start if the air temperature is above 35 ºF and rising. If temperatures are falling, the operation is required to stop when the temperature reaches 40 ºF.

If cold weather paving has been authorized, the water and/or the aggregate may have to be heated before the concrete is mixed. The temperature of the mix when placed is required to be between 50 to 80 ºF.

At no time is the concrete placed on a frozen grade. Artificial means may sometimes be used to keep the grade from freezing at night. Any concrete placed that may be subject to freezing is required to be sufficiently insulated. Insulation is usually achieved by a combination of plastic sheeting, blankets, or straw.

PLACING CONCRETE

Enough equipment and material supplies should be kept on hand to allow for a continuous operation. The timing of the delivery of concrete is critical to the quality of the pavement, especially for slip-form paving.

Precautions may be necessary to prevent segregation of the concrete materials while being placed. After placing, concrete should be re-handled as little as possible. Any re-handling should be done by a

machine or with a shovel (not with rakes). Equipment made of, or coated with, aluminum or aluminum alloys is not allowed to be used to place or transport concrete. All workers walking on the fresh concrete during placement are required to keep their footwear free of foreign material that may contaminate the fresh concrete.

Figure 6-5. Form Paving

Caution should be taken by all workers to not disturb joints, dowel bars, and assemblies. Machine mounted vibrators may have to be lifted to avoid certain joints, manholes, and other possible hazards. Hand held vibrators are required to be used to consolidate the concrete in these areas as well as any other area that may not be accessible to the machine mounted vibrators. Consolidating the concrete against the faces of all forms and joints is important.

Vibrators should not be used in any one spot for more than 15 seconds and should never come into direct contact with the side forms, joint assemblies, or the grade.

All manholes and similar structures are required to be adjusted to the proper grade and surrounded with preformed joint material before paving begins.

Any damage to adjoining pavements during the paving or any other related operation should be reported to the PE/PS. The Contractor is responsible for repairs to these areas.

PLACING REINFORCING STEEL

The concrete is deposited on the grade and spread by a mechanical spreader which also strikes the concrete off to the proper elevation for placing wire fabric. Concrete should be kept in front of the strike off at all times to prevent depressions in the pavement. Any depressions are required to be corrected before placing the wire fabric.

Reinforcing tie bars for longitudinal joints may be inserted into the concrete automatically by the paver. When paving two lanes at once, a straight tie bar is inserted every 3 feet along the longitudinal joint by the paver. If an adjacent lane is to be connected later to the lane currently being paved, tie bars are inserted into the edge of the pavement at 30 degrees to the perpendicular and bent straight after the concrete has set (Figure 6-6). If more than one of the deformed bars break in a panel during straightening, all broken bars shall be replaced with retrofitted tie bars.

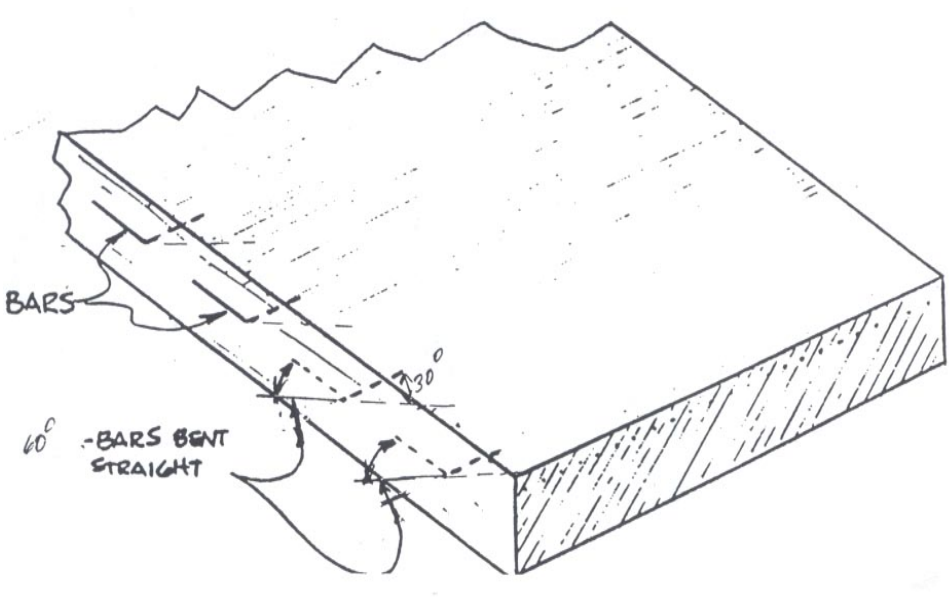


Figure 6-6. Tie Bar Placement

All reinforcing steel should be free from dirt, harmful rust, scale, paint, grease, oil, or anything else that may prevent the concrete from bonding to the steel. Mesh should be stored flat before placement so that the proper shape of the mesh wire is maintained during paving.

STRIKE-OFF, CONSOLIDATION, AND FINISHING

The paving equipment is designed to properly strike off, consolidate, and finish the concrete accurately to the required elevation and cross section. For this to occur, a sufficient amount of concrete is required to be carried in front of the screed (Figure 6-7) so that the paver is cutting the concrete at all times. All voids and depressions are filled if this procedure is used. The operation is controlled to ensure that an excess of mortar is not carried to the surface. If segregated particles come to the surface in front of the screed, they are required to be mixed back into the unfinished concrete by hand and not allowed to be pushed to the grade ahead of the concrete.

Figure 6-7. Paver Screed

Previously placed mesh should be observed for shifting as the final strike off proceeds. If the wire mesh is allowed to drift into a joint, a joint failure may occur.

When approaching a transverse expansion joint, concrete is poured over the joint ahead of the paver to provide stability to the joint assembly. The concrete around the joint is required to be properly consolidated to maintain the integrity of the joint. If the machine mounted vibrators or screeds are lifted to clear the joint assembly, consolidation may be done with hand held vibrators.

Hand methods of placing, compacting, and finishing (Figure 6-8) may only be used in the following situations:

1) For breakdowns of the finishing machine, and then only the concrete already mixed or being mixed
2) For widened portions at bridges, intersections, etc.
3) For certain widened portions of curves
4) For sections of pavement less than 600 feet long
5) For other places as permitted by the Specifications

When hand methods are required, the concrete is placed above the required grade and properly vibrated and struck off to obtain the desired results. If the width of the pavement is less than 4 feet, a simple board may be used to strike off the concrete after hand vibration. Wider pavements require a vibratory strike board. Bridge deck type finishers may also be used.

Figure 6-8. Hand Finishing

FLOATING

After proper strike-off and consolidation, the pavement is finished further by floating. This procedure may be done with a mechanical float which consists of large rollers which spin as they are moved across the surface. If specifically permitted, a hand float (Figure 6-9) of no less than 14 feet in length may be used. Hand floats should be checked for distortions that may cause a rough riding surface.

Floating is required to be continuous from edge to edge. When hand floating, a work bridge may be required for the finisher to walk upon.

Smaller floats of no less than 5 feet in length may be used to correct surface blemishes or irregularities.

Figure 6-9. Floating

CHECKING FINISH AND SURFACE CORRECTIONS

When the final floating is complete, a long handled 10 foot straightedge is pulled across the concrete to remove any surface irregularities, surplus water, or inert material that may be present from the previous operations. This will be the last opportunity to make corrections to the pavement and is an important process to assure pavement smoothness.

Once the straightedging is complete, an initial surface texture is created by dragging a double thickness of burlap over the pavement. Now the pavement is ready for tining.

TINING

The final finish for the pavement is achieved by tining which is a process of placing grooves in the pavement to aid in skid resistance. This is done by a machine (Figure 6-10) using a comb with steel tines. Tining may be done manually on ramps, connections, and other miscellaneous areas where machines cannot be utilized.

Figure 6-10. Machine Tining

The grooves for tining are required to be between 3/16 and 1/8 inches in width and between 1/8 and 3/16 inches deep.

Spacing of the tines is random and may be any of the following spaces:

1)	5/8 in.	10)	1 in.	19)	1½ in.
2)	1 in.	11)	3/4 in.	20)	7/8 in.
3)	7/8 in.	12)	7/8 in.	21)	3/4 in.
4)	5/8 in.	13)	1¾ in.	22)	7/8 in.
5)	1¼ in.	14)	7/8 in.	23)	1 in.
6)	3/4 in.	15)	3/8 in.	24)	7/8 in.
7)	1 in.	16)	1 in.	25)	1 in.
8)	1 in.	17)	1 in.		
9)	1 in.	18)	1¼ in.		

The required spacing at one time was 3/4 inch for all tines. This spacing created an irritating humming sound when vehicles drove on the pavement. The spacings described above break the rhythm and make the humming sound disappear.

Timing is very important for the tining process (Figure 6-11). If done too soon the grooves may be too deep or close up. If done too late, the grooves will not be deep enough. When the latter occurs, grooves are required to be cut into the concrete by machine after the pavement hardens completely.

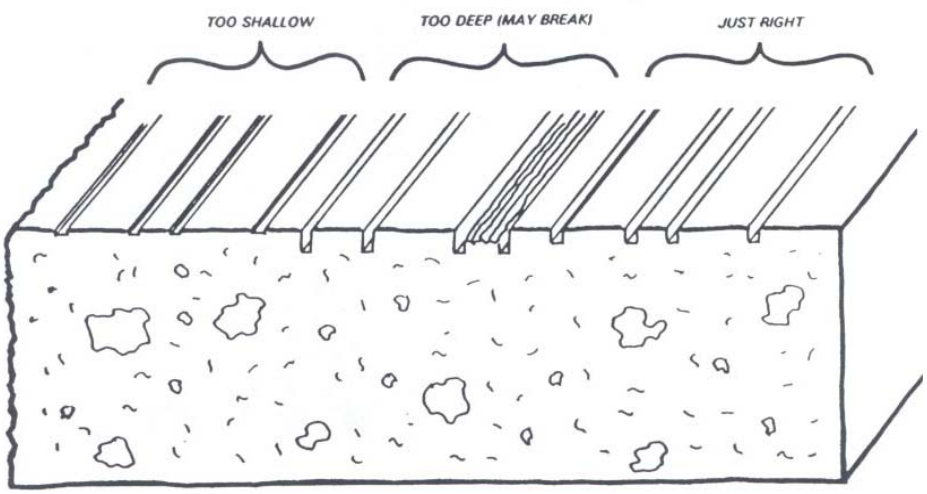


Figure 6-11. Tining Depth

EDGING

All edges of slabs and formed joints are required to be rounded to the radius indicated in the plans. This procedure is accomplished using a finishing tool called an edger (Figure 6-12).

Any tool marks left behind by the edger should be removed before the burlap drag is used. All joints should be checked with a straightedge to verify that no side of the joint is higher than the other. Corrections are required to be made immediately.

Figure 6-12. Hand Finishing Pavement Edge

EDGE SLUMP

When the slip-form method is used, special attention should be placed on the edge slump (Figure 6-13). The edge slump is defined as how far the edge of the wet concrete pavement slumps down after the slip-form paver has passed.

For 6 inches from the edge of the pavement, a maximum 3/8 inch edge slump from a typical cross section is required; however, if the edge is joined by another pavement slab, the edge slump may not exceed 1/4 inch. If edge slump requirements cannot be met, the PE/PS should be notified immediately. Additional trailing forms to support the edges longer may be needed to prevent the excessive edge slumping.

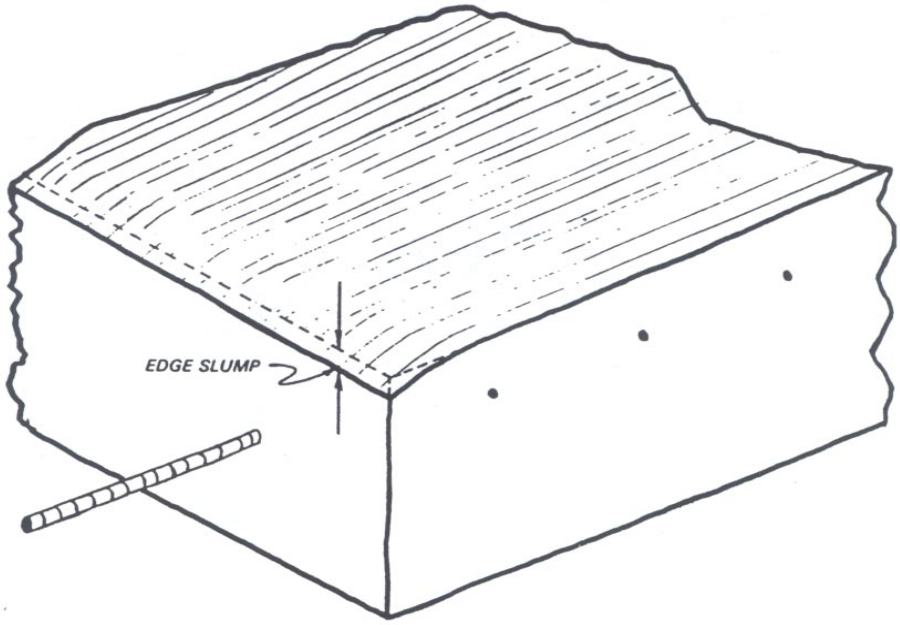


Figure 6-13. Edge Slump

PAVEMENT DATES AND STATIONS

The technician is responsible for placing the date and station numbers on the pavement. This is done immediately after tining, while the concrete is still plastic.

Cast iron dies are used to place the date and the plus station at the beginning of each days run. Full stations are also stamped every 100 ft (Figure 6-14).

Figure 6-14. Pavement Stamping

Station numbers are to be stamped on the right side of the pavement with the nearest digit approximately 8 inches from the edge of the pavement (Figure 6-15).

In the case of multiple lanes, the station numbers are placed along the outside edge of the pavement, readable from the same direction as the flow of traffic.

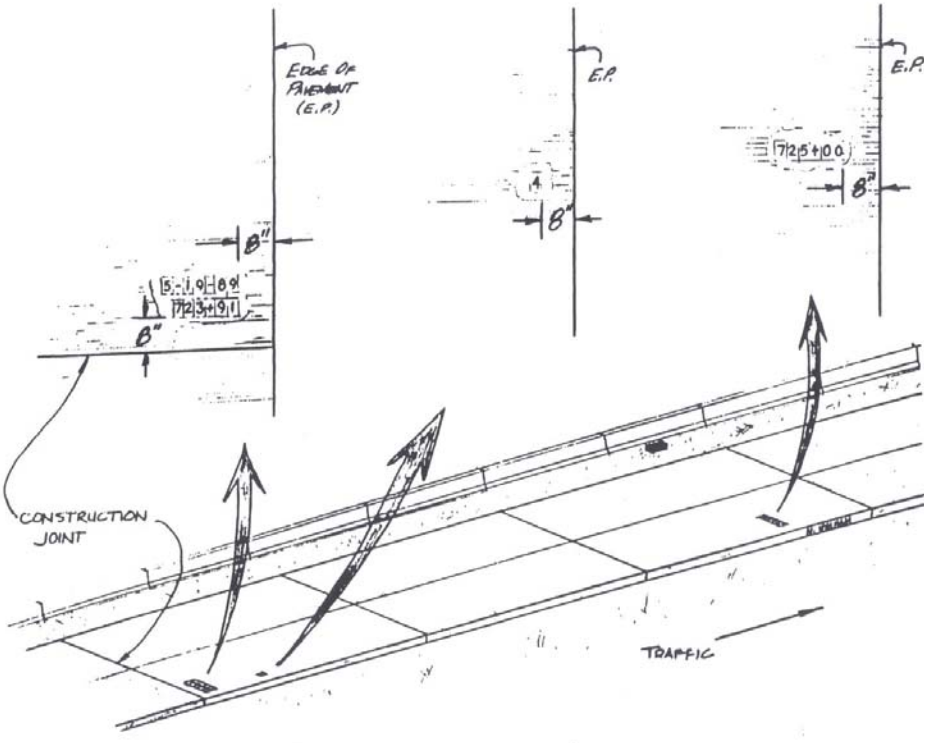


Figure 6-15. Pavement Stamp Location

CURING

Curing is as important to the integrity of the pavement as anything previously discussed. For proper curing, the pavement should retain moisture and be kept from freezing. The entire required curing period of 96 hours should be carefully monitored.

The methods used to retain moisture in the concrete include:

1) Wet burlap
2) Wet straw
3) Waterproof blankets
4) Ponding
5) Curing compound

WET BURLAP

When wet burlap is used, two layers are placed over the concrete pavement. The first layer is placed as soon as marring of the fresh surface may be avoided. The second layer of wet burlap is applied over the first before 9:00 a.m. of the next day. The burlap is required to be kept wet for the entire curing period.

WET STRAW

When straw is used, a layer of wet burlap is initially placed as mentioned above. Before 9:00 a.m. of the next day, the burlap is removed and replaced with 3 inches of straw. The straw is then thoroughly saturated and kept wet for the remainder of the curing period.

WATERPROOF BLANKETS

When waterproof blankets are used, the pavement is covered throughout the entire curing period. The blankets should be securely held down. All overlaps and edges are sufficiently sealed to keep the moisture from escaping. When using this method, the pavement is fogged or covered with wet burlap until the blankets are in place, which is required before 9:00 a.m. of the following day.

PONDING

When ponding is used for curing, the initial burlap is removed by 9:00 a.m. of the following day and the surface is immediately covered with two inches of water for the remainder of the curing period.

CURING COMPOUND

Curing compound is a white membrane that is sprayed onto the pavement immediately after final finishing and after the surface water has disappeared (Figure 6-16). After sufficient agitation, the compound is uniformly distributed over the surface to form a waterproof membrane. If the membrane is marred from foot traffic or equipment during the curing period, additional curing compound is required to be applied to the affected areas. Curing compound is applied at a rate of not less than one gallon per 150 square feet.

Figure 6-16. Curing Compound

When forms are removed, the edges of the pavement are required to be banked with earth 12 inches wide or covered by one of the curing methods listed above.

If there is a danger of freezing during the curing period, the concrete pavement should be further protected by a suitable covering of straw or blankets. During this period, temperature checks should be made under the covering at the pavement surface and recorded for permanent record.

PROTECTION FROM RAIN

Rain may be very detrimental to unhardened concrete pavement and measures should be taken to protect the pavement from this occurrence. Pavement operations are required to cease if rain appears likely to occur. The Contractor should have materials available at all times to protect the pavement in the event of an unexpected rain. If rain begins to fall, all available manpower should be utilized to place a protective covering, usually plastic sheeting, on the pavement. Planks or forms should also be available to protect the edges of the pavement when slip-form paving.

REMOVAL OF FORMS

Generally, paving forms may not be removed from fresh pavement until the concrete has been allowed to set for at least 8 hours. Forms may be removed at the ends of contraction joints as soon as joints may be sawed without raveling. Mechanical form pullers may not be used from the pavement side of the forms.

IC 739 State Form 11107

INDIANA DEPARTMENT OF TRANSPORTATION
CONCRETE PLANT INSPECTOR'S DAILY CHECK LIST

DISTRIBUTION: Project Engineer

BATCH WEIGHTS

ADMIXTURE: Type _____ Amt. ____ oz.
CA _____ lb. FA _____ lb. C _____ lb.
MAXIMUM WATER PER CYD. _____ gal.

CONTRACT NO. _____ PROJECT NO. _____ DATE _____

PLANT NAME _____ LOCATION _____

		YES	NO
1.	Has the plant been approved by Div. of Materials & Tests?		
2.	Are heating facilities available if required?		
3.	Are sufficient approved materials available for the pour?		
4.	Are aggregates stockpiled properly and separately?		
5.	Are aggregates maintained separately in the bins?		
6.	Are aggregates free of contamination?		
7.	Has aggregate had 12 hour drainage?		
8.	Is the cement storage weather tight?		
9.	Are records of cement shipments being kept?		
10.	Is there an adequate cement sampling port available?		
11.	Are there sufficient material samples to comply with Frequency Requirements?		
12.	Does the mixer have manufacturer information plate attached?		
13.	Is the mixer being used at or below rated capacity?		
14.	Is the mixer timer working properly and at the required setting?		
15.	Is the air entraining admixture dispenser working properly and accurately?		
16.	Are other chemical admixture dispensers working properly and accurately?		
17.	Have batch weights been checked by the Project Engineer or Supervisor?		
18.	Are (10) 50 pound test weights available for checking scales?		
19.	Have the scales been checked twice daily during operation for cleanliness, material buildup and "no load" balance?		
20.	Is the cement handled to avoid spillage after weighing?		
21.	Are accurate records of all batches weighed being kept?		
22.	Is the project being furnished a record of any batch changes on the individual concrete load when the change occurs?		

6-20

Daily Check List

	YES	NO
23. Do all trucks have working revolution counters? Any truck that does not have a properly working revolution counter will not be used.		
24. Do all trucks have manufacturer's information plates? Manufacturer's tags must be in place before truck can be used. Drum revolution shall be checked for compliance with manufacturer's recommendations.		
25. Is general condion of truck good? Trucks shall be checked for water storage (capacity, leaky valves, etc.), old concrete buildup, and general condition.		
26. Are trucks being used at or below rated capacity?		
27. Is truck free of concrete and wash water from previous loads?		

NOTE: If "NO" is checked for any of the above items, list under REMARKS the action taken to correct the situation. Any question that does not apply to the type of mixer used shall be marked DNA.

TRUCKS USED FOR POUR

Truck Number	Mfgr's Tags	Rev. Counter	General Cond.

CONCRETE POUR CHANGES (CENTRAL MIX & TRANSIT MIX)

Truck Number	Mfgr's Tags	Time	Total Yds. This Date	Change Made

REMARKS:

SIGNED _____

_____

Daily Check List